



## **HIGH SCHOOL BIOLOGY**

### **ASSESSMENT PART 2**

#### **GENETICS**

<b>Student ID</b>	
<b>Teacher ID</b>	



In this assessment you will be asked to complete a biology reading task about using biotechnology to improve food production. This is an assessment of your reading in biology. You will have one period to complete the assessment.

Thinking ahead: In Assessment Part 3, half of the class will go on to write an essay in response to the document in this assessment, while the other half will complete additional reading tasks.

## **READING TASK DIRECTIONS**

Please carefully read the following documents written about using biotechnology to improve food production. There are five sections. As you read, consider the five sections individually, but also think about how they relate to one another.

Show your thinking about the reading by taking notes in the margins or on the texts. These notes will be scored as part of the assessment on your reading.

Next, respond to the multiple choice and short answer questions after each section of the document.

**SECTION 1: Read carefully, record your thinking about the reading, and answer the questions that follow the section.**

*The following section was adapted from an online lesson on crop biotechnology and an online article written on genetically modified organisms.*

**USING BIOTECHNOLOGY TO IMPROVE FOOD PRODUCTION**

**The Scoop on Biotechnology**

What is "biotechnology"? Biotechnology can be defined in a number of ways. First, it can be defined as "the use of biotechnical methods to modify the genetic material of living cells so they will produce new substances or perform new functions." Second, it can also refer to genetic engineering technology of the 21<sup>st</sup> century used to directly manipulate the genes of organisms, such as moving or transferring genetic material between sources. Finally, the broadest definition of biotechnology is the use of living organisms to make a product or conduct a process. This includes using bacteria to make yogurt, cheese, and vinegar as well as the use of plant or animal cross-breeding techniques or genetic engineering to produce food with enhanced qualities. Therefore, methods of biotechnology include both the indirect and direct manipulation of genes, such as in the traditional cross-breeding and selective breeding in plants and animals, as well as in engineered recombinant DNA.

The link between biotechnology and food dates back almost 10,000 years, yet scientific experiments with biotechnology were not recorded in writing until the 1860's. Gregor Mendel was the first to document the results of his experiments in the carefully planned traditional cross-breeding of garden peas. Mendel used mathematics to conclude that each true-breeding pea plant had two identical copies of an allele for a particular trait. During meiosis, only one copy of each allele went into each pollen or egg cell. He referred to this separation of alleles in the first generation (F1) as the principle of segregation.

Since Mendel's time, traditional cross breeding has been used to develop lines of plants with desired qualities, such as orchids with brilliant color. Unfortunately, cross-breeding indirectly transfers many unwanted traits along with the trait of interest, and continued selective breeding is necessary to rid the new plant of these unwanted traits.

*Text continues on page 6*

**Sources:**

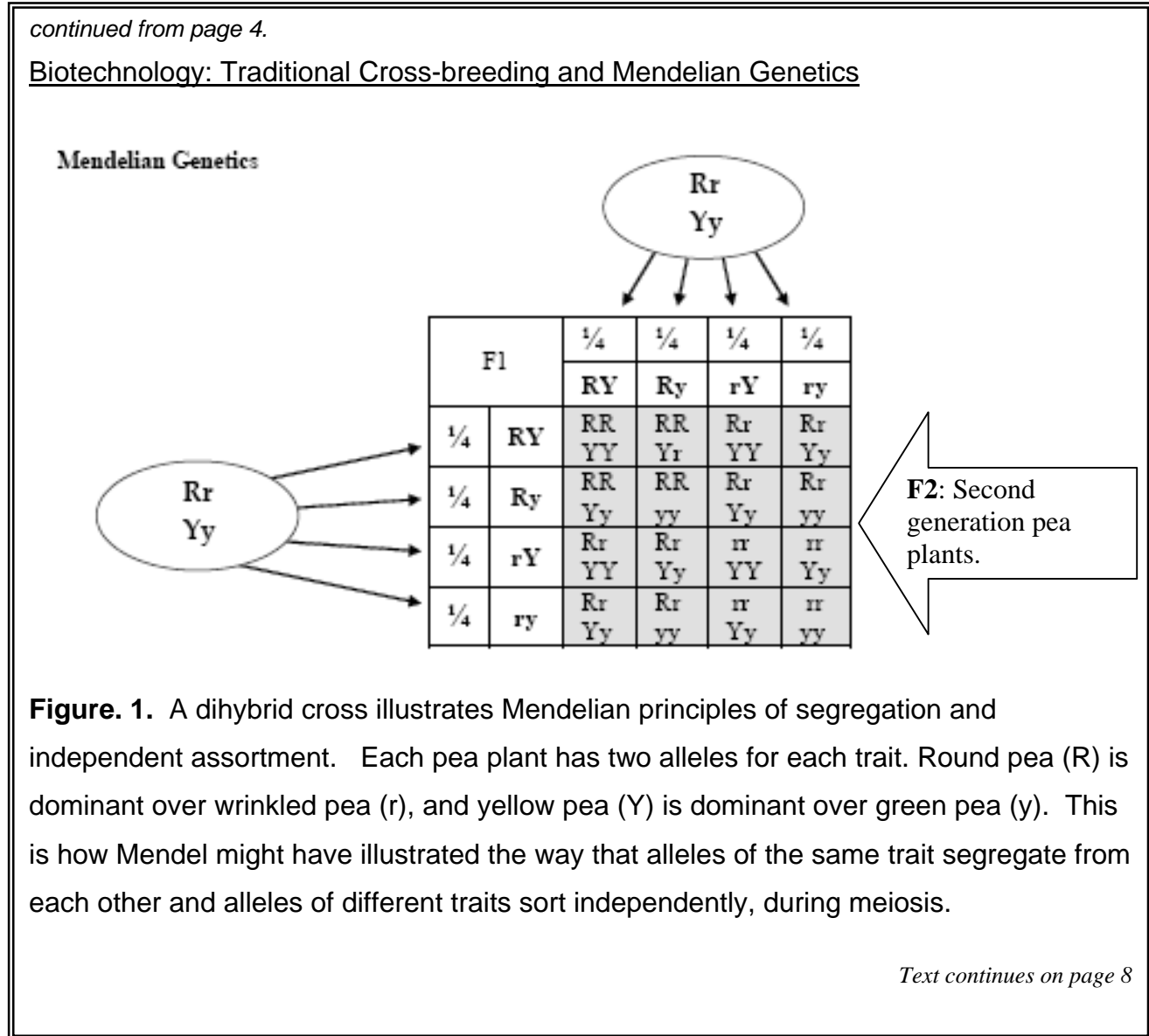
- 1) Jennifer Flak and Julie Albrecht, Department of Agronomy and Horticulture at the University of Nebraska.
- 2) Genetically Modified Organisms, Institute of Food Technologists. Internet publication.

## SECTION 1 QUESTIONS:

1. What does the following phrase refer to in the section? “During meiosis, only one copy of each allele went into each pollen or egg cell.”
  - A. The process of genetic engineering
  - B. The principle of segregation
  - C. The enhancement of the nutrient content of food
  - D. The genetic limitations of blueberries
  
2. In this section “to modify the genetic material of living cells” involves?
  - A. Adding one organism’s cells into another organism
  - B. Taking care of living cells as they modify themselves
  - C. Helping organisms become resistant to bacteria
  - D. Moving or transferring genetic material between sources
  
3. According to the section, traditional cross breeding:
  - A. Has not been used to develop plants with desired qualities
  - B. Involves the removal and transfer of DNA from one organism into another
  - C. Transfers many unwanted traits along with the trait of interest
  - D. Manufactures DNA to create new organisms

**SECTION 2: Read carefully, record your thinking about the reading, and answer the questions that follow the section.**

The following section is a figure illustrating traditional cross-breeding and Mendelian genetics, including information about the first and second generation of pea plants and the principles of segregation and independent assortment.



Source: BSCS Biology: A Molecular Approach. 8<sup>th</sup> Edition. Everyday Learning Corp., 2001. P 352-356.

## SECTION 2 QUESTIONS:

1. The first generation (F1) pea plants are:
  - A. Homozygous for shape with round seeds and homozygous for color with yellow
  - B. Heterozygous for shape with round seeds and heterozygous for color with yellow
  - C. Homozygous for shape with wrinkled seeds and homozygous for color with green
  - D. Heterozygous for shape with wrinkled seeds and heterozygous for color with green
  
2. Of the second generation (F2) pea plants, what proportion will have round phenotypes?
  - A.  $1/2$
  - B.  $1/4$
  - C.  $9/16$
  - D.  $3/4$
  
3. Which of the following statements is true for a dihybrid cross?
  - A. Each parent pea plant contributes alleles from two genes to its offspring
  - B. Each offspring inherits two genes from one parent and one from the other
  - C. There are 16 different possible genotypes of the offspring
  - D. None of the above statements are true of dihybrid crosses

**SECTION 3: Read carefully, record your thinking about the reading, and answer the questions that follow the section.**

*The following section was adapted from online lessons on crop technology and the genetic modification of organisms. It also contains information from a written publication about genetically modified organisms.*

*Continued from page 6*

The Scoop on Genetic Engineering

The most recent technique in biotechnology is sometimes referred to as genetic engineering. It was developed in 1973 and refers to the ability to directly transfer genetic information between organisms using molecular technology. Genetic engineering physically removes the DNA code for a particular gene from one organism and transfers it into the genome of another organism. A gene holds information that will give an organism a trait. Using this method, a single trait can be added to an organism at a time, making it much more efficient than traditional cross breeding.

Genetic engineering in this sense has been used in many areas related to food and nutrition. A recent focus of genetic engineering techniques has been to enhance the nutrient content of food. This area includes the development of oils with reduced saturated fat content and rice that has been modified to have high carotene levels (a vitamin A precursor). One early experiment attempted to alter tomatoes for the purpose of increasing their cold resistance, thus allowing a longer growing season. While not completely successful, this experiment illustrates the high hopes that scientists have for using biotechnology for the betterment of society. A group of California scientists used genetic engineering techniques to create a synthetic gene based on a specific flounder fish gene (that enables the fish to survive in very cold ocean waters) and inserted it into the DNA of a tomato seed. Today, scientists continue to investigate how genetic engineering can be used to improve quality of life.

*Text continues on page 10*

Sources:

- 1) Jennifer Flak and Julie Albrecht, Department of Agronomy and Horticulture at the University of Nebraska.
- 2) Genetically Modified Organisms, Institute of Food Technologists. Internet publication.
- 3) Online lesson in genetic modification of organisms.



### SECTION 3 QUESTIONS:

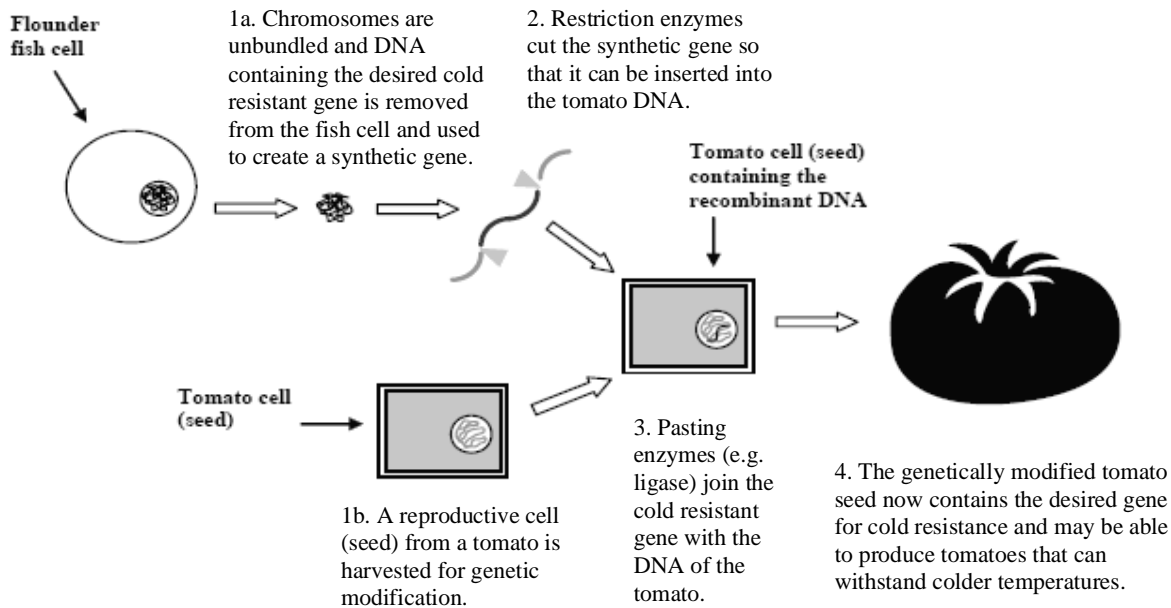
1. According to the section, genetic engineering can be used to:
  - A. Crossbreed rice to increase carotene
  - B. Develop oils with reduced saturated fat content
  - C. Crossbreed tomatoes in a carefully planned experiment
  - D. Divide alleles for one trait among gametes during meiosis
  
2. Which statement below most closely expresses the main idea of the section?
  - A. The principle of segregation developed in the late 1800s was the most recent innovation in biotechnology.
  - B. Mendel laid the groundwork for scientists to genetically modify organisms.
  - C. Genetic engineering can efficiently add desired traits to food plants by transferring a single gene from another organism to the food plant.
  - D. Scientists prefer to transfer large quantities of genetic information from one organism to another, giving them a wide selection of genes from which to choose when genetically modifying an organism.

**SECTION 4: Read carefully, record your thinking about the reading, and answer the questions that follow the section.**

*This section is a figure illustrating a form of biotechnology called genetic engineering using recombinant DNA. Included is information on the general step by step process used to genetically modify a tomato in an attempt to make it more resistant to cold temperatures.*

*Continued from page 8*

**Biotechnology: Genetic engineering and recombinant DNA**



**Figure 2.** The illustration above shows the process of splicing (joining) DNA containing the antifreeze gene and DNA from a tomato for the purpose of increasing the tomato's resistance to cold. First, the gene for cold resistance is extracted from the genome of the flounder fish and used to create a synthetic antifreeze gene. Using restriction enzymes and pasting enzymes, the antifreeze gene is cut and pasted with another piece of DNA called a plasmid. This hybrid DNA, which joins DNA from two different sources, is called recombinant DNA. The recombinant DNA is inserted into a bacterium that infects a tomato cell, transferring the hybrid DNA and integrating the cold resistance gene into the tomato DNA. The tomato cell's genome now contains the integrated gene for cold resistance and can be encouraged to grow into a tomato plant.

*Text continues on page 12*

Sources:

- 1) Online lesson in genetic modification of organisms.
- 2) J Dale and M von Schantz. From Genes to Genomes: Concepts and Applications of DNA Technology.

## SECTION 4 QUESTIONS:

1. In order for the tomato to acquire the flounder fish's cold resistant trait, a scientist needs to add the following to the tomato's DNA:
  - A. The genome of a flounder fish
  - B. Unbundled flounder chromosomes
  - C. A synthetic antifreeze gene
  - D. Pasting enzymes
  
2. Which of the following statements is true about this process?
  - A. The tomato will taste like flounder
  - B. The tomato seed can be used to produce tomatoes that may survive colder temperatures than before
  - C. The flounder fish egg will produce a fish that requires warmer water
  - D. Restriction enzymes join the antifreeze gene with the tomato's DNA

**SECTION 5: Read carefully, record your thinking about the reading, and answer the question that follows the section.**

*This section includes excerpts from various websites that illustrate a disagreement among scientists about the relative safety of genetic engineering, compared to traditional cross breeding.*

*Continued from page 10*

**Criticisms of Genetic Engineering**

1. From Greenpeace

- We have seen genetically modified soy beans whose stems crack in the heat, cotton plants that wither for no apparent reason, corn pollen that kills monarch butterfly larvae and probably other beneficial insects. And corn plants that exude pesticide into the soil. It's been shown that the pesticide then remains in the soil for over 200 days. That wasn't predicted and wasn't tested for.
- MON 863 is genetically engineered to produce a toxin against the cornborer, an insect that can cause damage to corn. Tests carried out on rats fed with MON 863 corn revealed they suffered liver and kidney damage. In 2005, we passed evidence of these tests to a team of experts headed by Professor Gilles Eric Séralini, a French governmental advisor on genetic engineering (GE), for independent evaluation. His study found "it cannot be concluded that GE corn MON863 is a safe product".

*Text continues on page 13*

## SECTION 5 CONTINUED

*Continued from page 12*

### **Criticisms of Genetic Engineering**

#### 2. From a PBS Teacher Education Website

- Genetic engineering involves the moving of genes that nature could never do. This could pose unexpected consequences.
- Genetic engineering makes use of pathogenic organisms such as viruses and bacteria to transfer genes. These organisms could spread into the environment with unpredictable and dangerous consequences.
- Genetic engineering is potentially dangerous and the consequences could be devastating and irreversible. Furthermore, the consequences could take years to show up.

*Text continues on page 14*

## SECTION 5 CONTINUED

*Continued from page 13*

### **Support of Genetic Engineering**

*A response to general concerns about genetic engineering from Professor Friedman, Stanford University Department of Biology*

Both traditional and genetic engineering approaches to plant breeding can increase yield, improve quality, and reduce growing costs. However, the processes are very different. For many, it is the process of genetic engineering and not the final product that is most worrying.

True, only genetic engineering (recombinant DNA) allows genes from two unrelated organisms to be brought together in unique combinations. This has been criticized for the possibility of creating new and unpredictable allergies and toxicities. But the American Medical Association, Board on Agriculture and Natural Resources and National Research Council, and Institute of Food Technologists, among other organizations, agree that genetically engineered food is no greater threat to human health than conventional food.

Consider the farmer seeking to transfer disease resistance from a wild species of corn to the type of potato grown on the farm. The traditional approach would be to cross the wild species with the domesticated species, producing an offspring having inherited half of its genes from one parent and half from the other. Then, to filter out the undesirable traits contributed by the wild species, the breeder would repeatedly cross the offspring with the cultivated species. However, this process is imperfect, so the new corn variety would not only have the disease-resistant gene, but also other genes from the wild species that may be undesirable.

Using genetic engineering, the resistance gene alone would be snipped from the DNA of the wild species and transferred to the cultivated variety, so the risk of altering the food in unpredictable ways is greater with the traditional approach than with genetic modification.

**SECTION 5 QUESTION:**

Parts of this section were complex. What did you do as you were reading to improve your understanding? Please be as detailed as possible.

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